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ARC WELDING IN ARGON IN CZECHOSLOVAKIA

The need to increase labor productivity in Czechoslovakia calls for the introduction of new work methods in many fields, including welding. Where steel can be welded by the Volodinov or Mikhailov methods and by use of a submerged electrode, light nonferrous metals and stainless steels must be subjected to arc welding in argon.

Two practical methods of inert-gas-shielded welding are currently in use: welding with a wolfram electrode, and semiautomatic welding with the electrode in the form of the welding wire. Both of these methods can be mechanized completely, thus accelerating production. The only inert gas which could be considered for use in Czechoslovakia at present is argon. The Ostrava Nitrogen Works is producing it pure enough for welding. Both of these methods are extremely suitable for application to light metals. such as aluminum and magnesium and their alloys. The advantage of inert-gas-shielded welding is evident even where alternating current is used, since no fluxes need be applied because of the cleansing properties of the inert gas which neutralizes the danger of corrosion of unremoved flux particles. The quality of the welds, their protection from oxidation by inert gas, and the acceleration of operating speeds, all of which are facilitated by these methods, are the principal reasons for welding even copper and its alloys in this manner. As compared to acetylene welding, the inert-gas-shielded method using argon tends to cause less deformation, because of the concentration of heat within a small space under the arc.

In welding in a stream of argon and using wolfram electrodes, or, to call the method by its Western name, Heliarc welding, a suitable material must be chosen for the nozzle, which is mounted on the holder and guides the stream of argon. In working with aluminum and its alloys it is possible to use nozzles manufactured from oxidized aluminum. For other materials, particularly copper and stainless steel, and also where direct current is used and in angle welding, these nozzles are unsuitable. A special, highly flame-resistant porcelain is used abroad. Various porcelains, pure silicon, and the Pythagorean substance have been tested in Czechoslovakia; all of these materials, however, melted in the high temperature in the vicinity of the arc. In the meantime, corundum nozzles are serving well. In large wolfram electrode holders, water-cooled nozzles

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are customarily used. The nozzles are usually insulated from their holders by a layer of ceramic material such as steatite. Inasmuch as the nozzle is water cooled, it is important to insulate all metal parts of the holder with rubber and disconnect the current when handling the apparatus.

Czechoslovakia does not produce its own wolfram electrodes; most of them are imported from Austria. Frequently, leftover pieces of electrodes, after atomic hydrogen welding, are used. Where larger electrodes are essential, bundles of them may be used. The most desirable number of electrodes to be used in one bundle is seven. Electrodes of material other than wolfram are unsatisfactory. Sometimes thorium and cerium are added, to improve the ability of the electrodes to emit electrons.

Where sheets of greater thicknesses are to be welded, the use of wolfram electrodes under argon has proved unsatisfactory, and the second method, making the welding wire itself act as electrode, is considered to be superior. Good results have been achieved in welding aluminum and its alloys, not only in laboratory tests but in practice as well. Sheets from 0.6 to 50-65 millimeters thick have been welded by this method. During operation, alternating current is used, the arc is stabilized by high frequency, and a condenser block for suppression is introduced. It is possible to hook the high-frequency stabilizing apparatus into the welding circuit either in series or in parallel. When connected in series, the full welding current passes through the high-frequency coil, which at this point must be either large or well cooled. A simpler device is available for hooking up in parallel.

The MEZ (Moravske Elektrotechnicke Zavody, Moravian Electrical Plants) research organization [in Nachod] has developed a prototype of such a high-frequency ionizing apparatus, which has a frequency of 2 megacycles. This frequency is outside the radio broadcast band, to minimize interference. The MEZ has also solved the problem of protecting the welding transformer by introducing a blocking condenser into the welding circuit.

In the case of transformers whose empty loads are a minimum of 100-120 volts, the high-frequency apparatus can be used only at the precise moment of ignition. In the case of transformers whose empty loads are 60-70 volts, the high-frequency apparatus must remain in operation constantly. By taking test readings, it was found that, considering the type of condensers produced in Czechoslovakia, it is necessary to choose a condenser block of a capacity of approximately 300 microfarads per ampere of welding current. It is further recommended that fuses be used for breaking the current, should the water supply for cooling happen to fail. With such a setup it is possible to weld sheets of maximum thickness as well as aluminum alloy castings. Preheating is not necessary, and the welding speed is faster than in acetylene welding. In welding thinner sheets, from 2 to 3 millimeters thick, it is possible to use the atomic-hydrogen welding transformer, which has a no-load voltage of 300 volts. It is then unnecessary to use either the condenser block or the high-frequency equipment.

Experiments in welding copper without use of flux have also been made. These have not yet been evaluated mechanically, but according to readings taken by microanalysis, the majority of the welds are porous. Copper and its alloys are welded primarily by use of direct current with direct polarity, that is, the electrode is connected to the negative pole. In this way a more concentrated temperature is imparted to the article to be welded, so that the work is sufficiently hot during operation and the weld is narrow and deep.

In tests, the PRAGA 500 motor generator has performed well. To hold waste of wolfram electrodes to a minimum, an 8-millimeter gap was installed between the chuck that holds the electrode (Czechoslovak design) and the mouth of the nozzle. However, the distance did not allow a sufficiently accurate stream of

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argon to be directed, which resulted in wavering of the arc. By increasing this gap 30 millimeters, this deficiency was corrected. Preheating of material does not influence its mechanical properties; it does, however, decrease porosity of the weld. Work is preheated to 350 and 450 degrees centigrade and occasionally to 600 degrees centigrade.

A weld free of pores has not yet been obtained successfully in nickel and its alloys. Special welding wire which acts simultaneously as a deoxidizing agent is recommended. On the whole, however, there has been little experience in this field. Good welds have been obtained in working with POLDI-AKV stainless steel, as long as columbium welding wire was used. With titanium wire, the welds were porous. Even here, however, perfect results may be obtained if the work is properly protected. This can be done by, for example, introducing a stream of argon on the underside also, possibly treating the underside with flux, or protecting it by a small hydrogen flame. It is noteworth that such metals as aluminum bronze, beryllium-copper alloys, "electron," other materials have been welded in Czechoslovakia.

Semiautomatic Welding.

Semiautomatic welding known in the West as Aircomatic or Sigma welding has been tried in Czechoslovakia and as compared to wolfram electrode welding has proved faster and more maneuverable. A bare wire which acts simultaneously as an electrode is used for semiautomatic welding. The wire is surrounded by a layer of inert gas, which eliminates the use of flux. CKD (Ceskomoravska Kolben Danek) Stalingrad has carried out experiments along this line with its own apparatus. These experiments are to continue next year.

An interesting development in semiautomatic welding is the self-regulating arc length. To keep the length of the arc constant, the welding wire is fed at a regulated speed. Incidental changes which would tend to lengthen the arc during operation automatically increase the tension in it. This reduces the current and causes the welding speed to drop. The balance between the welding speed and the feeding speed of the wire is disrupted, and the arc automatically shortens itself to its original size. Conditions which tend to shorten the arc act conversely. In practice, this phenomenon means that welding wire does not have to be fed electronically. The feeding speed is approximately 2.5-7.5 meters per minute; the diameter of the wire can be 1, 1.5 or 2.5 millimeters and the current, with aluminum for instance, 70-450 amperes.

At present, this method of welding is in its experimental stages in Czechoslovakia, although reports indicate that aluminum, copper, and their alloys have been treated in this manner. Experiments have also been carried out with stainless steel and nickel. The development of an apparatus for wolfram electrode welding has already reached the point where the devices could be delivered to Czechoslovak factories. Negotiations between the Commission for Inert-Gas-Shielded Welding and the former CZTS (Ceskoslovenske Zavody Tezkeho Strojirenstvi, Czechoslovak Heavy Machine Factories), aimed at delivering equipment to the leading Czechoslovak factories by the end of 1951, were progressing well, but have been broken off, and many enterprises badly in need of this equipment for carrying out their assignments are waiting for it in vain.

A further obstacle delaying the expansion of inert-gas welding is the prohibitive price of argon. The Ostrava Nitrogen Works will not be able to reduce the price (from approximately 1,200 crowns per cubic meter to 300 crowns per cubic meter) unless it is guaranteed a worthwhile market. In other words, the more enterprises use this method, the cheaper its use will become.

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